PIEZO-ELECTRIC RESONATOR

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Inventor: IDE TOSHINORI; TAKAYANAGI HIROAKI; HAYASHI TOSHIYA; WAKABAYASHI HISAO
Applicant: MIYOTA KK;; CITIZEN WATCH CO LTD
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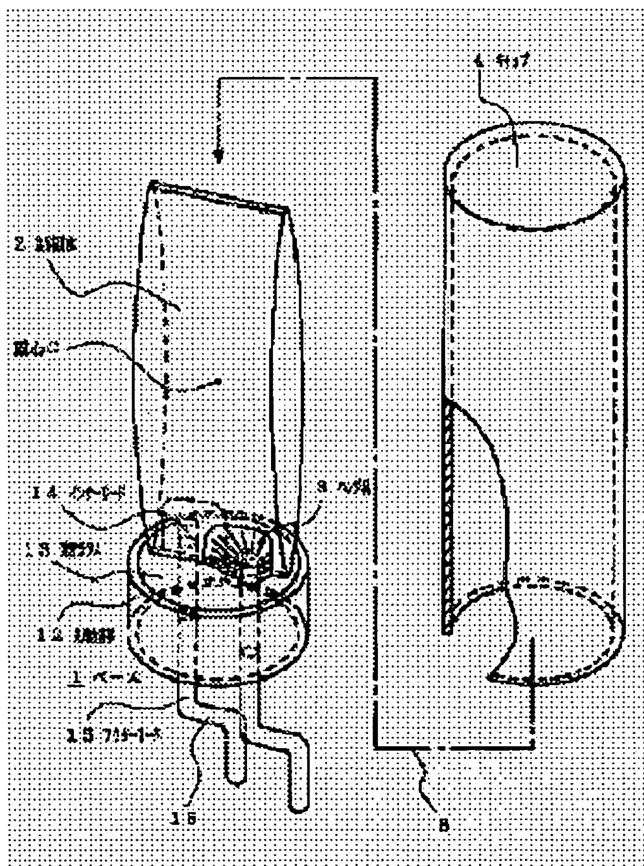
Abstract of **JP10154919**

PROBLEM TO BE SOLVED: To obtain excellent shock resistance, packability and productivity by previously plating a eutectic solder material on the outer circumferential metal part, the inner and the outer lead of a base, supplying and smelting a high-temperature solder paste to the inner lead and connecting it to the electrode of a piezo-electric resonator. SOLUTION: A cap 4 is made of copper nickel alloy such as nickel silver, and its inside face is plated by soft metal such as the eutectic solder material in the thickness of several &mu m almost the inside of the opening. A soft metal layer of the underside of the cap 4 and a soft metal layer on the surface of the base 1 keep pressure welding airtight when in force-fitting. A low-temperature solder which is plated on the outer circumference metal part 12 and a low-temperature solder which is plated underside the cap 4 are mutually pressure-welded by force-fitting to seal in airtight. At the time of mounting, though the high-temperature solder paste is heated and smelted, the occurrence of a solder ball and solder skip is extremely less comparing with the low- temperature solder. Even if there is droplet, it is immediately cooled and is hardly to stick to the piezo-electric resonator and a container or the like.



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to piezoelectric transducers, such as a quartz resonator which has the telescopic tight container by which the press fit closure is carried out.
[0002]
[Description of the Prior Art] The periphery which is the airtight terminal which made glass material penetrate the lead wire which consists of two or more covar etc. The base of a cartridge, The cap which consists of covar, nickel silver, etc. of the cylinder-like-object-with-base form which the press fit closure is carried out to periphery **** of the cartridge which consists of covar, an iron system alloy, etc. of this base, and forms the tight container of a piezoelectric transducer with this base, The configuration of the piezoelectric transducer which consists of piezo-electric oscillating objects mounted on said lead wire on said base with the pewter, such as a tuning fork mold oscillating object and a rectangle AT-cut mold oscillating object, is common knowledge conventionally.
[0003] In order to make an elasticity metal placed between the press fit closures, to maintain an airtight in the conventional technique and to improve soldering nature to lead wire, a piezo-electric oscillating object, and an external circuit To the inlet-port inner circumference section of a cap, the periphery section of the base, and lead wire, the pewter material of an eutectic system is plated, respectively. It is common to supply the paste which mixed the pewter material and flux of an eutectic system to the inside part of lead wire, to make the electrode of a piezo-electric oscillating object contact the part, to heat, to carry out melting of the pewter paste, and to mount a piezo-electric oscillating object. In addition, strictly [an eutectic pewter], before and after 62 % of the weight of Sn, although the ingredient of Pb remainder is pointed out, a component is Sn and, as for the alloy called an eutectic system pewter (wide sense) or a low-temperature pewter in explanation of this invention, Pb assumes what may also contain add-in material, such as 2 or about 3% of Ag, 0 thru/or 60% of the weight, as for the great portion of remainder. The location of the liquidus line in the Sn-Pb state diagram of this low-temperature pewter material becomes below 232-degreeC that is the melting point of tin.
[0004] the purpose which raises the thermal resistance of a piezoelectric transducer -- lead -- there is the conventional example which used rich pewter material for the piezoelectric transducer. As the (1), both the techniques currently indicated by JP,64-68007,A use the elevated-temperature pewter for the mounting section of a piezo-electric oscillating object, the base, and the closure section of a cap. According to this reference in an elevated-temperature pewter, the melting point is 260 to 327-degreeC, and an Sn pair Pb ratio is about 1:9. Moreover, as a conventional example (2), the technique currently indicated by JP,64-62909,A forms the lead system deposit which becomes only the periphery section of the metal ring which constitutes the base from a lead alloy. Although, as for these techniques, the purposes differ, a part of the configuration is common in this invention.
[0005] Moreover, there is a trouble about shock resistance. A quartz resonator came to be used abundantly in recent years at the pocket device used with stocks, such as a portable telephone. Therefore, the demand of a commercial scene to shock resistance is still crueller, for example, must be

equal to several free fall to the 100 thru/or wood slab top from 150cm with a simple substance.
[0006] The amelioration proposal of conventional some is proposed about shock resistance. As for the technique of the indication to conventional example (3) JP,61-247775,A, Shore hardness carries out support (to base side) fixing of the piece of a quartz resonator with 90 or less photosensitive adhesives with D scale. The addition lead (what fabricated the solder with which an example becomes the 10th power (Pa) of 1.95x10 to tabular [short]) which turns into a short inner lead from the quality of the material below Young's modulus 5.0x the 10th power of 10 (Pa) in conventional example (4) JP,4-78211,A is attached, and the piece of a quartz resonator is pasted up at the tip. moreover, conventional example (5) JP,7-14132,B -- setting -- the drawer to the piece electrode of Xtal, and the exterior -- adhesion immobilization of the conductor is carried out with the electroconductive glue containing an epoxy resin, a polybutadiene resin, petroleum system resin, and conductive powder (it has flexibility).
[0007] Moreover, the very small pewter particle dispersed with rapid heating in the case of mounting besides the shock-proof problem (call a pewter ball and a pewter jump), and it remained in the container, or it adhered to the piezo-electric oscillating piece, and the probability to cause the yield fall of poor CI value and the poor oscillation in low drive level was not able to be disregarded for the conventional example which uses the paste of low-temperature pewter material for mounting of a piezo-electric oscillating object (when a heat-resistant demand is not severe).
[0008]
[Problem(s) to be Solved by the Invention] The concrete trouble of the conventional example is considered. Although the conventional example (1) and (2) use elevated-temperature pewter material, if the elevated-temperature pewter material to the base is plated ordinarily, as for the inside parts (inner lead) of the periphery metal section of the base, and the tight container of lead wire, and a lateral part (outer lead), elevated-temperature pewter material will be plated by the whole surface. lead -- a rich alloy tends to produce a firm oxide film on a front face, and becomes difficult with [in the usual temperature in the case of mounting a piezoelectric transducer in an external circuit substrate] a pewter (it corresponds to the melting temperature of an eutectic system pewter). Then, elevated-temperature pewter plating had to be specially removed from the outer lead, it had to dip into the eutectic system pewter (it is hard to form an oxide film), the production process increased, and it was expensive. Moreover, the pewter layer by this DIP had bad mounting nature because of the variation in the amount of pewters in being hard to carry out bending (to refer to - drawing 1 arranged with the height of the side face of a cap, in order to make it stick to the circuit board) of an outer lead, since thickness is uneven. Moreover, although silver plating like the conventional example (2) makes soldering nature good, since it is an expensive ingredient, it is that (about 0.1-0.2-micrometer flash plating) which does not carry out thickness plating, and a silver film is beaten by the part which bent lead wire, a lower elevated-temperature pewter is exposed, and soldering nature (at mounting temperature) worsens. Moreover, once it will mount, silver will be lost in a substrate pewter, and what (reuse of the components collected from the non-used circuit board is often performed) is mounted again becomes impossible. On the other hand, since a low-temperature pewter is a cheap alloy and it can perform plating of sufficient thickness, re-mounting of it is attained.
[0009] Since an unsolved point still exists in management, the hardening process, and dependability of adhesives, I want to avoid the use again by the conventional example (3) about a shock-proof improvement, and (5). For example, although the breadth of melting pewter material will imitate correctly the configuration of the metal pattern of a piezo-electric oscillating body surface if it is pewter mounting, by un-hardening, since the breadth of liquefied adhesives is not regulated, it has the variation in an adhesion location, and it causes variation in CI value or reinforcement. Moreover, when mounting of the piezo-electric oscillating object between which the addition lead of the small dimension in the conventional example (4) was made to be placed increases the die length of lead wire and the overall length of a piezoelectric transducer is increased, junction of a different-species lead cannot but become workability is bad and difficult [on mass production] extremely.
[0010] It is going to solve in the piezoelectric transducer of the application of which thermal resistance is not comparatively required in this invention, considering the shock-proof above-mentioned problem at

other properties. That is, shock resistance is improved, mounting nature and re-mounting nature is also good, and does not have the futility of internal arrangement of a piezoelectric transducer, either, the purpose of this invention has substantially neither the problem of the internal generation of gas, nor the problem of scattering of a pewter, and, moreover, a manufacturing cost is offering the piezoelectric transducer maintained by the lowness near a limit.

[0011]

[Means for Solving the Problem] The piezoelectric transducer which comes to carry out press fit closure of the metal cap which supplied the elevated-temperature pewter paste to the inner lead, and fused, connected with the electrode of a piezo-electric oscillating object, mounted [to the periphery metal section of the base, the inner lead, and the outer lead, the pewter material of an eutectic system is plated beforehand and], and performed eutectic system pewter plating to the inside at this in a vacuum.

[0012]

[Embodiment of the Invention] Drawing 1 is the perspective view showing the structure of the gestalt of one operation of this invention. 1 is the base which is an airtight terminal and an appearance makes a cylindrical shape or an ellipse cartridge. The periphery metal section 12 which consists of covar etc., sealing glass 13, and this sealing glass 13 are penetrated, and it consists of lead wire, such as covar the outcrop of whose is an inner lead 14 and an outer lead 15. The periphery metal section 12 and both the outcrops of two lead wire are plated with eutectic system pewter material by the thickness of about several micrometers before mounting of a piezo-electric oscillating object. Although the component of an usable pewter is 60 % of the weight from lead 0, it is desirable that it is about 40% of range which is the presentation near [lead 0 to] the eutectic point especially. It is because the fault of the color which soldering nature is not so good and a blemish tends to attach softly becoming blackish, and the component management of plating liquid which is not beautiful becoming difficult is conspicuous if 40% of lead is exceeded if it becomes what. 16 is the stage bending section of an outer lead. The protrusion height of an inner lead 14 is diameter (for example, 0.3mm) extent of lead wire mostly. 2 is a Xtal oscillating object and uses the well-known shape of a convex and a well-known plate-like rectangle AT cut. The Xtal oscillating object 2 has the extension (not shown) of excitation electrode layers, such as silver, on the edge front face, arranges a major axis with the shaft of the base 1, and inserts it in the gap of two inner leads, and the extension of said electrode layer of a front flesh side and each of an inner lead are connected by the elevated-temperature pewter material 3.

[0013] This soldering is performed as follows. The base [finishing / eutectic system pewter (low-temperature pewter) plating] 1 is put in order and stood on a fixture. The paste which only the location which moreover hits the head of an inner lead 14 exactly piled up the metal screen mask which the hole has opened and can apply a paste, kneaded the spherical particle and rosin system flux of elevated-temperature pewter material, and adjusted it to desired viscosity is printed, and the paste of optimum dose is made to adhere to the perimeter of an inner lead 14. After that, the Xtal oscillating object 2 is inserted in the gap of an inner lead 14 so that the electrode layer may touch a paste drop and may get wet, and connection and mounting of the Xtal oscillating object 2 are completed by letting the reflow furnace of the temperature which exceeds the melting point of an elevated-temperature pewter for the whole pass. Since the lower limit of the Xtal oscillating object 2 is carried out almost in contact with the top face of the base 1, the die length of a cap can be managed with the minimum, and it does not make the clearance which allows survival of a pewter ball in a clearance while it attains the miniaturization of a completion quartz resonator.

[0014] If the amount of a paste drop is managed appropriately, the pewter material 3 fills the gap of the side face of an inner lead 14, and a Xtal oscillating object front face (electrode layer), and it will form the pewter lump 3 with which the facies of the method of both sides of an inner lead and a point which reach the front face of the Xtal oscillating object 2 carried out the Mt. Fuji mold, reducing thickness gently-sloping toward the upper part further. As for the elevated-temperature pewter material used by this example, lead uses the alloy 90 % of the weight or more and whose remainder are mainly tin. Little silver etc. may also be included. Although the low-temperature pewter material whose lead is 0 thru/or 60 % of the weight beforehand is plated, an inner lead 14 sets up the pewter lump's 3 volume so that the

twice of the volume (surface area x plating thickness of an inner lead) may be exceeded, and it may become 5 times or 10 or more times preferably. Moreover, the thing of one dimension in the path of an inner lead 14, width of face, or die length jutted out in the direction in which the part of Susono of a **** and the pewter lump 3 has the center of gravity G of the Xtal oscillating object 2 from the tip of an inner lead 14 more than it across one half to the volume of the inner lead itself at least is desirable at least. It is because this overhang part is considered to protect the Xtal oscillating object 2 by deforming moderately at the time of an impact. Thus, if a pewter lump's volume is enlarged enough, even if low-temperature pewter material dissolves, as for the lead content of an average of the pewter lump 3, about 85% or more will be secured. Thus, the Young's modulus of pewter material is low stopped by making a pewter lump's final presentation into lead Rich. Young's modulus is in the inclination which becomes so low that a leaden component ratio increases.

[0015] 4 -- a cap -- it is -- for example, copper-nickel alloys, such as nickel silver, -- changing -- at least -- the inside -- opening -- elasticity metals, such as eutectic system pewter material, are plated a little with the thickness of several micrometers to the inside. The vacuum lock of the cap 4 is pressed fit and carried out in the 5 activity directions shown with an alternate long and short dash line in a vacuum from right above the base 1. Furthermore, as a closure postheat treatment, heating for one day thru/or five days is performed by 80 thru/or 140-degreeC. The elasticity metal layer of the inside of cap 4 and the elasticity metal layer of base 1 front face maintain a pressure-welding airtight at the time of press fit. Therefore, as for the thickness of both elasticity metal, it is desirable to be set to about 15 micrometers in total. Moreover, the pewter lump's 3 crystal grain makes it big and rough by the closure postheat treatment, and the Young's modulus of a supporter falls further.

[0016] The pressure welding of the low-temperature pewter plated by the periphery metal section 12 and the low-temperature pewter of each other plated by cap 4 inside is carried out by press fit, and it performs a hermetic seal cooperatively by it. Although the total thickness of an elasticity metal layer is the about [15micrometer] need, it can be distributed to the base and a cap half-and-half. Namely, there should just be several micrometers plating thickness of the low-temperature pewter to the base. This advantage is in that the plating thickness to an inner lead may be thin. That is, although the low-temperature pewter plated by the inner lead lowers the component ratio of the lead in penetration and the pewter lump 3 after mounting to the elevated-temperature pewter lump 3 of piezo-electric oscillating object mounting, there is few extent of the fall. That is, the rise of a pewter lump's Young's modulus is suppressed low. However, since the low-temperature pewter left behind to the cap inside will fuse, a steam will be generated and the property of a piezoelectric transducer will be injured although an airtight will be maintained even if the pressure-welding side of the closure melts by the draw-down effectiveness if heating exceeding the melting point of a low-temperature pewter is performed to the whole piezoelectric transducer at the time of mounting to the circuit board of a piezoelectric transducer, there is a fixed limitation in the whole thermal resistance in the configuration of this invention. However, since the terminal point of heat conduction is an elevated-temperature pewter lump to heating of an outer lead, it is quite strong.

[0017] Although heating melting of the elevated-temperature pewter paste is carried out at the time of mounting, in the case of elevated-temperature pewter material, as compared with a low-temperature pewter, there is very little generating of a pewter ball or a pewter jump. Moreover, since it will get cold immediately even if there is a pewter droplet, it is hard to adhere in a piezo-electric oscillating object or a piezoelectric transducer container.

[0018] Now, the effectiveness of the pewter supporter about the shock resistance of a piezoelectric transducer is examined. First, probably in the free-fall test of a cylindrical piezoelectric transducer wood slab above the floor level, it will be the weakest, namely, the condition of being easy to fracture an internal piezo-electric oscillating object is the case where it collides with a floor with the posture (or the horizontal and piezoelectric transducer tip side of a long side became [the shorter side of a piezo-electric oscillating object] downward a little mostly) which leveled the principal plane (plate surface) mostly, when a piezo-electric oscillating object is an AT cut. Probably to a foot crease, a horizontal or a principal plane has an almost perpendicular principal plane (U appearance of written words) similarly,

and a longitudinal shaft (symmetry axis) is a horizontal or a little downward case, when a piezo-electric oscillating object is a tuning fork mold. About the example of this invention which used the rectangle AT-cut oscillating object for below, two kinds of pewter material from which a component and Young's modulus differ the buffer effect of a supporter is taken up for an example, and is considered numerically.

[0019] Drawing 2 is the front view and side elevation which expanded the pewter lump's 3 part. The pewter lump's 3 form is idealized. Since a flat-surface configuration imitates the vacuum evaporationo electrode pattern of a Xtal oscillating body surface, it is quite exact. A cross-section configuration becomes an irregular form somewhat according to the amount of a pewter paste. The pewter lump 3 includes the inner lead 14 which touches the Xtal oscillating object 2 mostly, makes a summit the side face distant from the Xtal oscillating object 2, and has become the configuration finished reducing thickness toward the edge of the large pattern on a Xtal oscillating body surface, and lengthening Susono. The Xtal oscillating object 2 is sandwiched by the pewter lump 3 in the both sides of a principal plane. According to a mechanical property (rigidity), it divides into three parts from a base inside towards the center of gravity (core) of the Xtal oscillating object 2. A is to the tip of an inner lead 14, and this regards it as what acts as the rigid high rigid-body section extremely. Since the part which B is a pewter hem part, and becomes quite smaller than the A section although rigidity changes with locations is included, it is considered to some extent that resiliency carries out an owner atony opposition operation to the force (or moment) by the impact which is going to sag the Xtal oscillating object 2 in the direction 8 perpendicular to a plate surface. C is a part which the Xtal oscillating object itself bends and demonstrates spring nature to the inertial force of the total mass (it will be regarded as what is being concentrated on the center of gravity in approximation) of the Xtal oscillating object 2. And the part of the center-of-gravity beyond of a Xtal oscillating object is disregarded (from a supporter). (finishing [mass / the mass of this part is included in lumped mass, and / consideration])

[0020] In an example, the diameter of an inner lead is [the die length of the C section to 0.25mm and a Xtal oscillating weight alignment of the die length of about 0.3mm, the A section, and the B section] 2.5mm. Moreover, a frequency is 8MHz, the overall length of a Xtal oscillating object is 6mm, and width of face is b= 1.6mm. 0.212mm and both-ends thickness the maximum thickness in the core (center of gravity G) of a Xtal oscillating object 0.123mm, The thickness in the boundary of the B section and the C section is 0.150mm, and if both sides are assumed to be the cylinder surfaces which consist of the secondary curve (thickness y is shown in [1] type) which makes a core top-most vertices By integrating with this curve and applying width of face, the volume of a Xtal oscillating object is set to 3 1.7494mm, therefore mass is calculated with m= 4.636mg. (The consistency of Xtal is 3 2.65mg/mm) Cross-section second moment [in / in addition / the arbitration cross section of a Xtal oscillating object] Iq The formula is shown in [2].

[0021] Drawing 3 is the pewter lump 3 of the example of this invention, and the sectional view of a Xtal oscillating object, and shows the X-X cross section of drawing 2 . It is expressed with hatching from which the cross section in the B section of the pewter lump 3 and the Xtal oscillating object 2 differs. It is assumed that the B section carries out bending deformation by making the flat surface passing through the core of the thickness of a Xtal oscillating object into a neutral plane 6. (Bottom along which count is for convenience although it is not strictly exact since this assumption does not have the pewter lump's 3 symmetrical location and form about a neutral plane 6.) In the part of thin Susono of the pewter thickness which demonstrates the spring effectiveness, an error becomes small. Many of other dimensions used for count are width of face of a= 0.1mm of the pewter lump's 3 summit, width of face of c= 1mm of the skirt, and b= 1.6mm (above) of Xtal oscillating ****. Moreover, z and distance from the neutral plane are set [the one half of Xtal oscillating object thickness] to e for the width of face of the surface of dmm and a pewter cross section. z shall change between a and c linearly along Susono of the pewter section (related with the x-coordinate which made the fixed end of a Xtal oscillating object the zero, and took it towards the center-of-gravity side). Cross-section second moment Is of the pewter lump in the Xtal oscillating object upper and lower sides in the arbitration cross section of the B section It is expressed with [3] types.

[0022]
[Equation 1]

$$2d=y=-0.00992(x-3)2+0.212 \quad (mm) \qquad [1]$$

$$Iq=\frac{bd3}{12} \ (mm4) \qquad [2]$$

$$Is=2\int (d\rightarrow e)\ y2\ z\ dy$$
$$=\frac{[c\ (3d4-4d3\ e+e4)+z\ (3e4-4e3\ d+d4)]}{[6\ (e-d)]} \ (mm4) \qquad [3]$$

Notes: A half-width figure expresses a multiplier. The inside of the parenthesis next to an integral notation expresses the integral range.
[0023] In the B section, the section from x= 0.25mm to 0.5 is equally divided into five, six cross sections are taken, and d, Iq, and Is are calculated by [1], [2], and [3] types about each cross section. Next, they are Eq and Es about the Young's modulus of the Xtal material and pewter material, respectively. It carries out. Eq =7454kg pile/mm2, Es1=4300kg pile/mm2 (the tin used conventionally -- an example Sn of a rich low-temperature pewter -- 96%) They are Iq of each cross section, and Is as 2 (lead used for this invention actual measurement of rich example Sn8% of elevated-temperature pewter material, and Pb 89.5% of thing) the actual measurement of Pb 0.05% of thing, and 2= 1600kg pile [/mm] Es. An advantage is taken. (The semantics of a subscript, q=quartz, s=support, a 1= low-temperature pewter, and 2= elevated-temperature pewter) W= 1kg pile of loads of imagination perpendicular to a plate surface is further hung on the center-of-gravity location of a quartz plate (neither Xtal nor a support system shall fracture by carrying out the variation rate proportional to a load), and the bending moment which acts on the cross section considered according to the load is set to M (kg pile mm). The die length of the hem part B section of a pewter is as short as 0.25mm, and long distance and bending moment [which acts on the B section since it is separated about 2.5mm] M presupposes that it is almost uniform and is M= 2.5kg pile mm from the Xtal center of gravity.
[0024] In this way, in 1-/rho=di/dx ([4] types) in a certain obtained cross section, rho is the radius of curvature (mm) of bending bending of a neutral plane, and i is a bending angle (rad). Therefore, all bending angles is of the B section It will be obtained if it integrates with [4] types from the starting point x= 0.25 of the B section to 0.5. What is necessary is just to carry out numerical integration of this integral from the value of [4] types in each above-mentioned cross section using a trapezoidal rule etc. Description of the fine process of count is omitted. The result of having embraced the pewter quality of the material (low temperature and elevated temperature) is shown in [5] types. Moreover, the displacement delta of the center of gravity of the Xtal oscillating object resulting from the bending applies the distance of l= 2.5mm to a center of gravity to a bending angle, and is obtained ([6] types). And the load rate Ks ([7] types) converted into the center-of-gravity location of a Xtal oscillating object was obtained as spring nature of the pewter supporter B section after all. Although there is nothing and large buffer nature was expected about 37.2% of that of low-temperature pewter material, if the Young's modulus of elevated-temperature pewter material looks at [7] types, the ratio in the load rate of a support system has stopped to about 61.8%. Since the Xtal material with Young's modulus high as the heart pinched by the pewter material of a front flesh side exists, this is because the effectiveness by the difference in pewter material was thinned.
[0025]
[Equation 2]

$$\frac{1}{\rho}=\frac{di}{dx}=\frac{M}{(Eq\ Iq+Es\ Is)} \qquad [4]$$

$$i\ s1=0.04543,\quad i\ s2=0.07356\ (rad) \qquad [5]$$

$$\delta 1=0.11358,\quad \delta 2=0.18390\ (mm) \qquad [6]$$

$$K\ s1=8.8044,\quad K\ s2=5.4377\ (kg重/mm) \qquad [7]$$

$$\delta q=1.1948\ (mm),\quad Kq=0.8370\ (kg重/mm) \qquad [8]$$

[0026] Next, since the Xtal oscillating object itself has the buffer spring effectiveness, I will ask for the load rate. This load rate Kq It is the ratio of W= 1kg pile of loads added to the center of gravity G of a Xtal oscillating object at right angles to a plate surface in approximation, and the variation rate of the center of gravity G by bending bending of the Xtal oscillating object body by it. Contributing to this bending bending may regard it as the part from the edge by the side of B of the C section to a center of gravity G in drawing 2 . This part is the cantilever of the uniform quality of the material from which a cross section (thickness) changes, and Load W is acting on that free end. Imitate, when it asks for bending of the above-mentioned B section, since it is not the uniform quality of the material, and some cross sections are taken at equal intervals to the longitudinal direction of the Xtal cantilever. The cross-section second moment Iq ([2] types) by the load W in each cross section, Ask for bending moment M (suppose that it is uniform in the middle section of a cross section), and it is referred to as Young's modulus Eq =7454kg pile/mm2 (above) of Xtal. If it asks for the amount contributed of the variation rate of the center of gravity G by bending bending of each section by [4] types (the term Es Is of pewter material disregarded) and they are added, they are synthetic (based on the Xtal oscillating object C section) variation-rate deltaq of a center of gravity G, and a load rate Kq. It asks. The result was shown in [8] types.

[0027] Drawing 4 is a model Fig. explaining the behavior by the fall impact which joins a quartz resonator. By the following explanation, relation between already calculated Kq, Ks, m, and shock resistance (size of the stress generated on a Xtal oscillating object by the impact) is clarified. In drawing 4 , inside the cap 4 of a quartz resonator, there are a spring (load rate Ks) equivalent to the support spring with which the end was fixed to the container, and a spring (load rate Kq) equivalent to the Xtal oscillating object body connected to the other end at the serial, and the equivalent mass m in the center of gravity of a Xtal oscillating object is further hung at the tip. Spring Ks Spring Kq The synthetic load rate of a serial spring is set to K ([9] types). Thus, the modeled piezoelectric transducer shall fall from height h on a wood slab 7 with the worst posture explained above. Each part of a piezoelectric transducer changes to the kinetic energy corresponding to [in the potential energy equivalent to the difference h of height] the collision rate v by the time in front of a collision. Although a container stops with a collision, the piezo-electric oscillating object equivalent mass m of contents continues movement from habit. Therefore, Spring K is extended only in order [s] to absorb the kinetic energy of mass m exactly. (Although the energy which a spring should absorb turns into potential energy equivalent to the sum of the kinetic energy or the fall height corresponding to the sum of the absolute value of a collision rate and a recoil rate, and recoil height when a container does not stop by collision but it recoils, there is no change in a model or the essence of a phenomenon.) Below, since it is easy, it is assumed that a container stops after a collision. The energy U which Spring K should absorb is shown in [10] types. the inside g of a formula -- gravitational acceleration -- it is -- g=980 cm/sec2 it is .

[0028] For the following count depended on the model of drawing 4 , the fixed kinetic energy of the piezo-electric oscillating object by fall is Kq. Ks Although distributed and absorbed In that case, support load rate Ks A way small (compliance is large or it is soft) to some extent is the equivalence spring nature Kq of a piezo-electric oscillating object. The energy absorbed decreases more. Therefore, it is going to show quantitatively that the stress which is going to make a piezo-electric oscillating object break becomes small.

[0029] [10] the collision rate v which can be found by the formula, and the maximum center of gravity --

a variation rate -- s is shown in [11] types. Moreover, [12] types showed the maximum stress sigma which generates the moment which acts on the fracture surface (AT quartz plate is fractured in the C section very near the B section of drawing 2 in almost all cases) of Xtal according the force generated in a center-of-gravity location with displacement s to f and its force f in the fracture section cross section of Xtal with M and its moment. In addition, it is the so-called section modulus, sets to the fracture surface, and Z is 3 Z= 0.006mm as y= 0.150mm with the 8MHz AT cut of an example. It becomes. In the case of m= 4.636mg and h= 100cm, in the case of the above-mentioned conventional low-temperature pewter material, it is a subscript 1. It gives and, in the case of the elevated-temperature pewter material of this invention example, is a subscript 2. It gave and the count result of having applied the concrete numeric value ([7] types, [8] types) of an example by [12] types from [9] types was described by [19] types from [13] types.

[0030]

[Equation 3]

$$\frac{1}{K}=\frac{1}{Kq}+\frac{1}{Ks} \quad ; K=\frac{Kq\ Ks}{(Kq+Ks)} \qquad (9)$$

$$U=mgh=\left(\frac{1}{2}\right) mv2=\left(\frac{1}{2}\right) Ks2 \qquad (10)$$

$$\therefore v=\sqrt{(2gh)}, \qquad s=\sqrt{\left(\frac{m}{K}\right)}\ v \qquad (11)$$

$$f=Ks, \quad M=fl, \quad \sigma=\frac{M}{Z}, \quad Z=\frac{by2}{6} \qquad (12)$$

$$U=454.29\ (erg), \quad v=442.7\ (cm/sec) \qquad (13)$$

$$K1=0.76434\ kg重/mm=7490500\ dyn/cm \qquad (14)$$

$$K2=0.72535\ kg重/mm=7108400\ dyn/cm \qquad (15)$$

$$s1=0.011018, \quad s2=0.011311 \quad (cm) \qquad (16)$$

$$f1=0.084215, \quad f2=0.082044 \quad (Kg重) \qquad (17)$$

$$M1=0.2106, \quad M2=0.2051 \quad (Kg重mm) \qquad (18)$$

$$\sigma1=35.10, \quad \sigma2=34.18 \quad (Kg重/mm2) \qquad (19)$$

[0031] Although explanation of the dynamics of an impact and the approach of count became very long above, since the required count result in the example of contrastive pewter material was obtained, below, it comparison-inquires and the numeric value is considered. It was said above that the difference was shortened for the existence of the hard Xtal core material although there was originally great difference in the Young's modulus of the pewter material first used for the supporter (drawing 2 B section), and it became the ratio of about 1= 61.8% of Ks2/Ks(es) from [7] type numeric value. K1 of this time [14] type and [15] types K2 It approached further with K2/K1 =94.9% for comparing. although this is based also on the thickness of how to commit the moment or a cross section -- general -- a long plate -- bending -- easy -- a short plate -- bending -- being hard -- although -- since the body of a quartz plate is sufficiently long -- the load rate Kq small -- having become (compliance being size) -- on the other hand, Ks2 and Ks1 are because rigidity is numerical size highly, so the difference of the synthetic load rate of [9] types will thin further comparatively for the short bulk of the drawing 2 B section. Since the ratio about an ingredient is in inverse proportion to root (K2 / K1) proportionally after all from a formula [16] about each of the variation rate s by [19], Force f, bending moment M, and stress sigma, the difference thins further. Although it should think that the comparison of the stress sigma by pewter material different, for example served as an index of final shock-proof evaluation since it was thought that fracture of the Xtal material took place when the stress value of the Xtal material reached fracture threshold value, it is sigma2/sigma1 =97.4% and the stress difference became about 2.6% from [19] types.

[0032] although comment that it is not like [which the effectiveness using pewter material which is different in glancing at this count result expected] may be drawn -- that is not right -- rather -- lead --

that several% of decrease of stress can attain certainly should evaluate positively what was proved in strength of materials by using rich pewter material. The calculated value of the Xtal bending stress in the case of being a little higher than fall height of 1m or it with a demand of a commercial scene is obtaining the bending stress value acquired by the fracture experiment which actually imposed the static load on the Xtal oscillating object, and quite good coincidence. This also shows the validity of dynamic consideration of the impact described above. Thus, when the shock resistance of a piezoelectric transducer is just before the highest needs of a commercial scene, also although it is called several% of improvement even if, the contribution to the dependability of a product is large, and the industrial value is high.

[0033] According to the experiment in our company, that whose shock resistance in low-temperature pewter use was fall height of about 75cm has been sharply improved to 1.2m to 1.5m by elevated-temperature pewter use. lead -- apart from [the reason which can be conjectured that shock resistance is greatly improvable by use of rich pewter material / again] said count, since at least two exist, they explain it.

[0034] The (1) is the effectiveness based on the stress-distorted property of pewter material. If a test piece is created by pewter material and a tension test is performed, the increment of tensile stress will decrease in monotone with a distorted increment, without being hardly proportional to elongation distortion, and will draw the curve of the configuration similar to the forward part of a logarithmic curve. unlike the metallic material (it has the range where stress is proportional distorted) with the Young's modulus of pewter material hard generally, this curvilinear configuration shows that average Young's modulus (= -- certain stress/which receives distorted -- the -- distorted) in the meantime becomes a low value, so that distortion is large, and that there is probably a hysteresis about deformation repeatedly and an internal loss is a large ingredient although it is unidentified. If the Young's modulus used by the count before performed over several pages was in the distortion value of 0. several percent which is the values calculated from the inclination of the curve in early stages of [****] deformation, and is the maximum distortion which may be produced from the above-mentioned count in 1m fall in a pewter supporter (B section), it turned out that average Young's modulus decreases below in one half of initial value. The low-temperature pewter (thing near tin) and elevated-temperature pewter is also well alike, and the average Young's modulus of mist beam elevated-temperature pewter material of the downward tendency is quite lower at the case where a distortion value is high.

[0035] if the view in the above-mentioned count is seasoned with these knowledge (a re-calculation is not easy and is stopped to qualitative consideration, since it becomes a nonlinear phenomenon) -- advance of the deformation of a supporter by the process of an impact -- a low elevated temperature -- any case of pewter material -- the Young's modulus -- decreasing -- said calculated value -- large -- deforming -- equivalence load rate Ks It becomes small and the stress of Xtal is reduced. however, lead -- in rich pewter material, since distortion of the deformation of a supporter, therefore pewter material is more large, it comes out, and since I will be, having expanded the Xtal stress ratio with the case of low-temperature pewter material rather than 2.6% whose final deformation decline in Young's modulus advances more and increases further and which it is as a result of [front] count is expected. Furthermore, probably, the buffer action by changing into heat a part of vibrational energy in which it occurs by the impact, the elastic hysteresis of the above-mentioned pewter material, i.e., the internal loss, other than effectiveness accompanying this Young's modulus reduction, and diffusing it also coexists. Although the quantitative difference by the pewter material is not clear now, the lead known as an easy ingredient of plastic deformation is imagined whether the direction of rich pewter material is effectiveness size.

[0036] The (2) is the difference of the stress concentration effectiveness. Drawing 5 R> 5 is the edge of the pewter lump's 5 hem part in the gestalt of operation of this invention, and drawing of longitudinal section of the Xtal oscillating object 2 of the neighborhood, and is illustrating distribution of the stress 22 which the neutral plane 6 in the cross section 21 right-angled on the longitudinal shaft of the Xtal oscillating object 2 in the marginal location of a hem part generates up and down by bending moment M. There is much what has finished with the boiled-fish-paste mold on the steep slope, without a pewter

lump's edge lengthening the skirt as shown in drawing 5 in the piezoelectric transducer actually produced. Near the front face of the Xtal oscillating object 2 in a corner 24 produces stress concentration for [of the pewter lump 3] rigidity, when bent. In that case, therefore, the stress on a cross section 21 If there is no pewter lump 3, it will be surmised the place which should carry out the linear increment which is proportional to distance from a neutral plane 6 as shown by the stress distribution straight line 23 that it becomes the distribution to which the maximum stress in a front face increases more as shown by the stress distribution curve 25 in practice. The fatigue limit (the maximum stress value which does not start fatigue breaking to repeated-load change of an infinity time) of the round bar with a stage which according to the mechanical-engineering handbook receives bending while rotating falls from the fatigue limit of the smooth round bar with equal thin part and thin diameter of the round bar with a stage for the stress concentration of the fillet section, the scale factor of the fall exceeds 1.0, and when the R (radius of curvature) of the fillet section is small and sharp, it has a publication that it amounts also to 2.5. It can be said that this is because the maximum of stress will actually increase for the scale factor in the fillet section if bending is received, and even 1 time of a load without a repetition is the same. The stress distribution of drawing 5 is guessed from this publication. However, the scale factor will become smaller than the value indicated by the handbook, since it differed in that the configuration with a stage consists of the different quality of the materials of a pewter and Xtal instead of the continuous quality of the material and the soft pewter has wrapped hard Xtal in this example. if imagination is added and said -- the scale factor 2.5 (by the electrode pattern, a pewter lump's skirt does not have a melting pewter, a corner 24 does not have an R at that of **** stop ****, and it becomes sharp -- it comes out, and since I will be, maximum is adopted as a basic scale factor) in the uniform quality of the material -- for example, -- further -- the ratio of the Young's modulus of pewter material and the Xtal material -- Es/Eq etc. may start (a low-temperature pewter 0.577 and an elevated-temperature pewter 0.215). (-- however, a scale factor is not less than 1 -- I will come out.) -- under an assumption [like], if the Young's modulus ratio of a low-temperature pewter is hung on said scale factor 2.5, a scale factor will be set to 1.44 and increase of remarkable stress will become a certain thing. However, if an elevated-temperature pewter is used, a scale factor will be set to 1 (since the value of a product is set to 0.538< 1, let it be a scale factor 1), and stress concentration will completely be lost. That is, since the reinforcement of Xtal material original is demonstrated by full, there will be marked effectiveness.

[0037] It supplements about the component and the property of the elevated-temperature pewter material used for this invention. The graph and drawing 7 which show reinforcement [as opposed to the leaden weight component ratio and leaden temperature change in pewter material in drawing 6] are the binary-condition Fig. of a tin lead alloy. As low-temperature pewter material plated beforehand, the component ratio, i.e., a leaden weight ratio, from which the melting point (location of the liquidus line of drawing 7) becomes about 232 degrees C or less of the melting point of pure tin is suitable for 0 to 60% of range to the base and lead wire of a piezoelectric transducer. Moreover, it is chosen so that, as for the component ratio of the lead in the elevated-temperature pewter material used for mounting of an oscillating object, the presentation after cooling may become 98% from about 85% in consideration of the low-temperature pewter material plated by the inner lead although even 100% even of lead was the selectable range fusing the highest at the time of mounting, and mixing with elevated-temperature pewter material. 85% of a lower limit is a value in which the solidus line of drawing 7 is not less than the melting point of pure tin, and it was determined that 97% of upper limits maintained the reinforcement which is extent with which the mounting section of a closure completion piezoelectric transducer is also heated in drawing 6 .

[0038] Moreover, the gestalt of other operations of this invention is described. Even if piezo-electric oscillating objects are other formats, for example, a tuning fork mold piezo-electricity oscillating object, there is no change substantially. Moreover, a piezo-electric oscillating object can be made into both **** depending on a internal structure. It is not necessary to limit lead wire to a circular cross section. It is not necessary to insert a piezo-electric oscillating object by the inner lead, and it may be arranged in one side of a piezo-electric oscillating object, and may carry out pewter mounting. In this case, since a pewter supporter is collected into one side of a piezo-electric oscillating object, that compliance can be

lowered, and the effectiveness of elevated-temperature pewter use will become more remarkable. Moreover, in case low-temperature pewter plating is beforehand carried out to the base, performing substrate plating of copper etc. is also included. Moreover, the quality of the material of a cap can consider iron cheaper than nickel silver, an iron alloy, aluminum, an aluminum containing alloy, copper, SUS material, a copper-nickel-tin alloy, etc.

[0039]

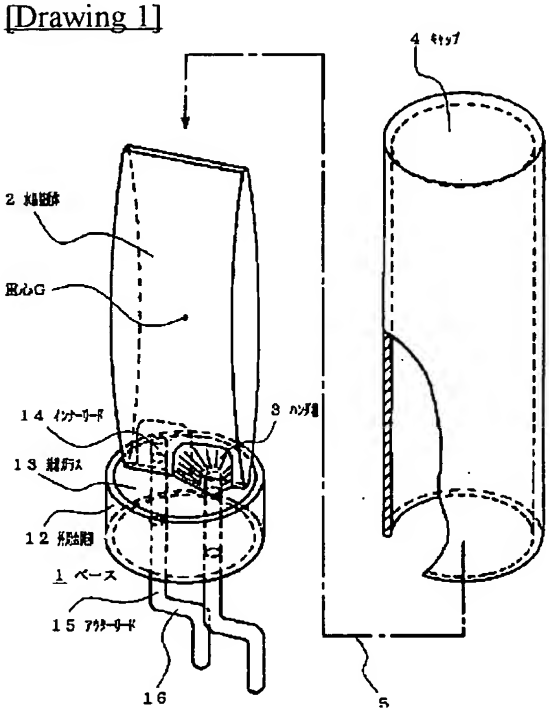
[Effect of the Invention] It sets to the piezoelectric transducer of this invention, and he is an elevated-temperature pewter lump with the big volume (for example, more than the volume of an inner lead) to mounting of a piezo-electric oscillating object. It becomes rich. or the tip of 2 double ** of the volume of the pewter material plated by the inner lead, or an inner lead -- further -- previously -- the breadth more than the path of an inner lead; or one half of width of face -- having -- since it used -- a pewter lump -- enough -- lead -- As the big buffer effect was obtained and it was obtained with experimental data according to a comprehensive operation of low Young's modulus, its non-line type reduction effectiveness, internal friction, stress concentration relaxation, etc., advanced shock resistance was obtained. This canceled location gap of mounting in the conventional technique which used adhesives (conductivity) for the buffer, and decreased CI (equivalent resistance value at the time of resonance), and the variation of Co (interelectrode capacity value). Moreover, it becomes unnecessary to have added the pars intermedia article for a buffer to the inner lead like other conventional examples, and all risk, such as complication of structure, a rise of assembly cost, an increment in the overall length of a piezoelectric transducer, and a pewter ball residual, was able to be avoided. Moreover, scattering and adhesion of a pewter of mounting therefore by the elevated-temperature pewter were lost.

[0040] Moreover, since the volume of the pewter lump of the above-mentioned piezo-electric oscillating object mounting section was sufficiently large, the fall of the lead component ratio of the pewter lump by the penetration of plating of an inner lead was able to be suppressed sufficiently small.

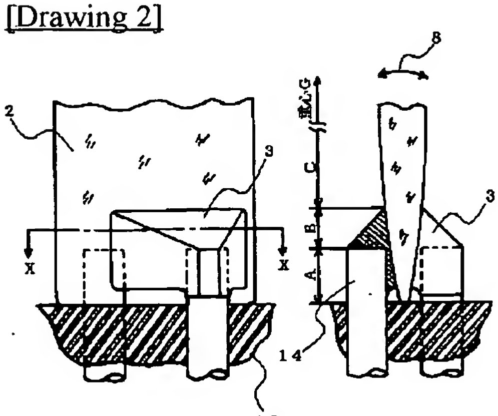
[Translation done.]

DRAWINGS

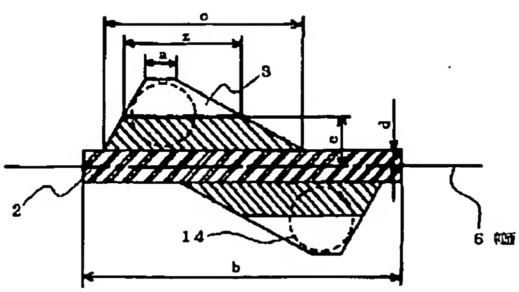
[Drawing 1]



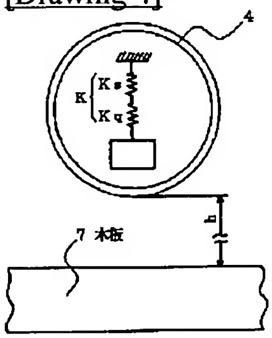
[Drawing 2]



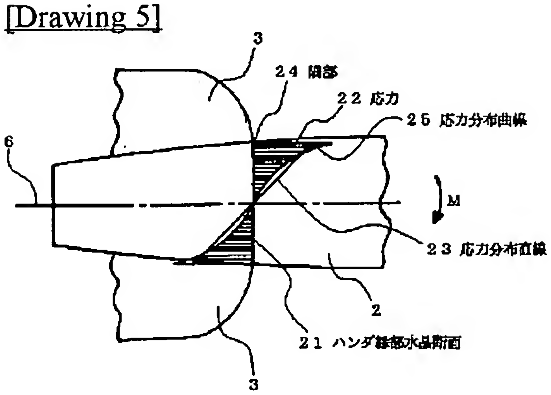
[Drawing 3]



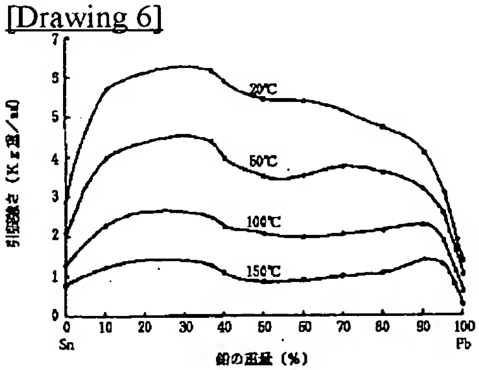
[Drawing 4]



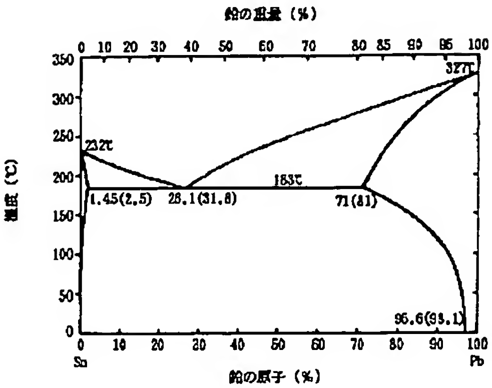
[Drawing 5]



[Drawing 6]



[Drawing 7]



[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The periphery which is the airtight terminal which made two or more lead wire penetrate The base of a cylindrical shape or an abbreviation ellipse cartridge, The metal cap of the hollow cylinder-like-object-with-base form which the press fit closure is carried out to the periphery metal section of this base, and forms the tight container of a piezoelectric transducer with this base, In the piezoelectric transducer which consists of the piezo-electric oscillating object which is on said base and was mounted on said lead wire in said tight container with the pewter The lateral part of said periphery metal section of said base and said tight container of lead wire is plated in lead by the pewter material containing 0 thru/or 60 % of the weight. The inner lead and said piezo-electric oscillating object of this lead wire are a piezoelectric transducer which is joined in lead by 85 thru/or the pewter material included 97% of the weight, and is characterized by said cap consisting of the metal to which elasticity alloy plating was performed.
[Claim 2] Said periphery metal section and lead wire of said base are beforehand plated in lead by the pewter material containing 10 thru/or 60 % of the weight. The inside part of said tight container of this lead wire and the electrode layer prepared in the front face of said piezo-electric oscillating object After the paste which consists of the elevated-temperature pewter material which contains lead 90% of the weight or more is supplied, fuse this paste and it is joined. The presentation of the pewter material in the joined this part is a piezoelectric transducer according to claim 1 characterized by lead being 85 thru/or 97 % of the weight as a result according to the effectiveness of the pewter material plated beforehand.
[Claim 3] Said pewter material which joins said inner lead and said piezo-electric oscillating object is a piezoelectric transducer according to claim 1 or 2 characterized by making the pewter lump which has the overhang section which turns said inner lead to the center of gravity of said piezo-electric oscillating object from the tip of this inner lead with a wrap mostly, and crosses the one half of the path of said inner lead.
[Claim 4] The volume after said pewter lump's solidification is a piezoelectric transducer according to claim 2 characterized by being over the twice of the volume of the pewter material beforehand plated by said inner lead before melting into this pewter lump.
[Claim 5] The volume after said pewter lump's solidification is a piezoelectric transducer according to claim 1 to 4 characterized by being more than the volume of said inner lead.
[Claim 6] The piezoelectric transducer according to claim 1 to 5 characterized by performing heat treatment for 80 to 140-degreeC and one day thru/or five days after fusing the paste which consists the inside part of said tight container of said lead wire, and the electrode layer prepared in the front face of said piezo-electric oscillating object of said elevated-temperature pewter material and joining.

[Translation done.]